# United States Patent [19]

**Lambert et al.**

[11] **3,952,637**

[45] **Apr. 27, 1976**


[54] **APPARATUS FOR CHANGING THE ROTARY POSITION OF A SLOTTER MEMBER AND FOR CHANGING THE RELATIVE POSITION BETWEEN FIXED AND MOVABLE KNIVES ON THE SLOTTER MEMBER**


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[73] Assignee: **Koppers Company, Inc.,** Pittsburgh, Pa.



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[21] Appl. No.: **567,488**

[52] **U.S. Cl.** ..... **93/58.2 R;** 83/332; 83/522; 83/699

[51] **Int. Cl.**[2] ..... **B31B 1/22;** B26D 7/26

[58] **Field of Search** ..... 83/332, 675, 678, 522, 83/699; 93/58.2 R, 58.2 F



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| 3,466,982 | 9/1969 | Sullivan | 93/58.2 R |



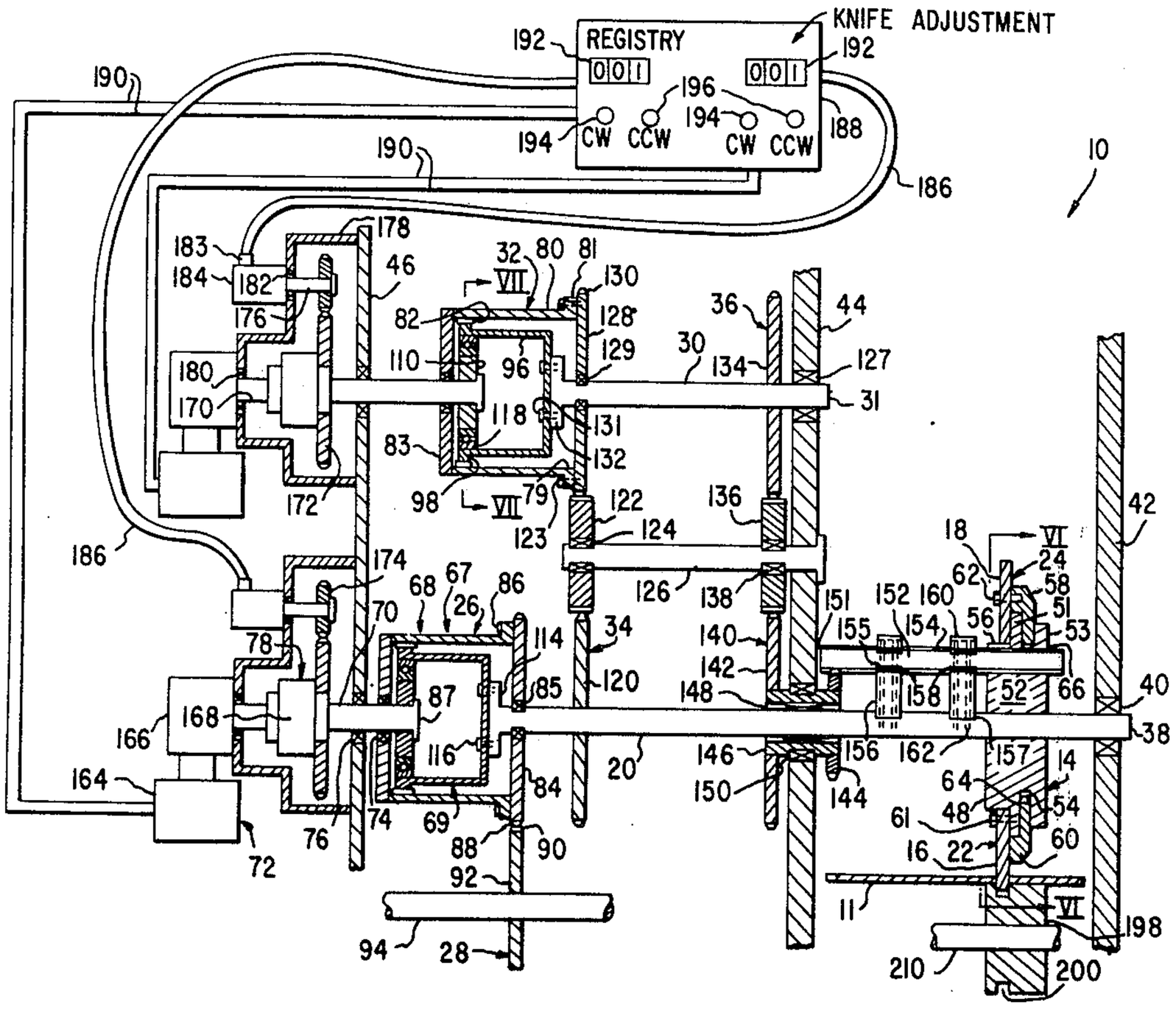
*Primary Examiner*—Frank T. Yost
*Attorney, Agent, or Firm*—Oscar B. Brumback; Boyce C. Dent

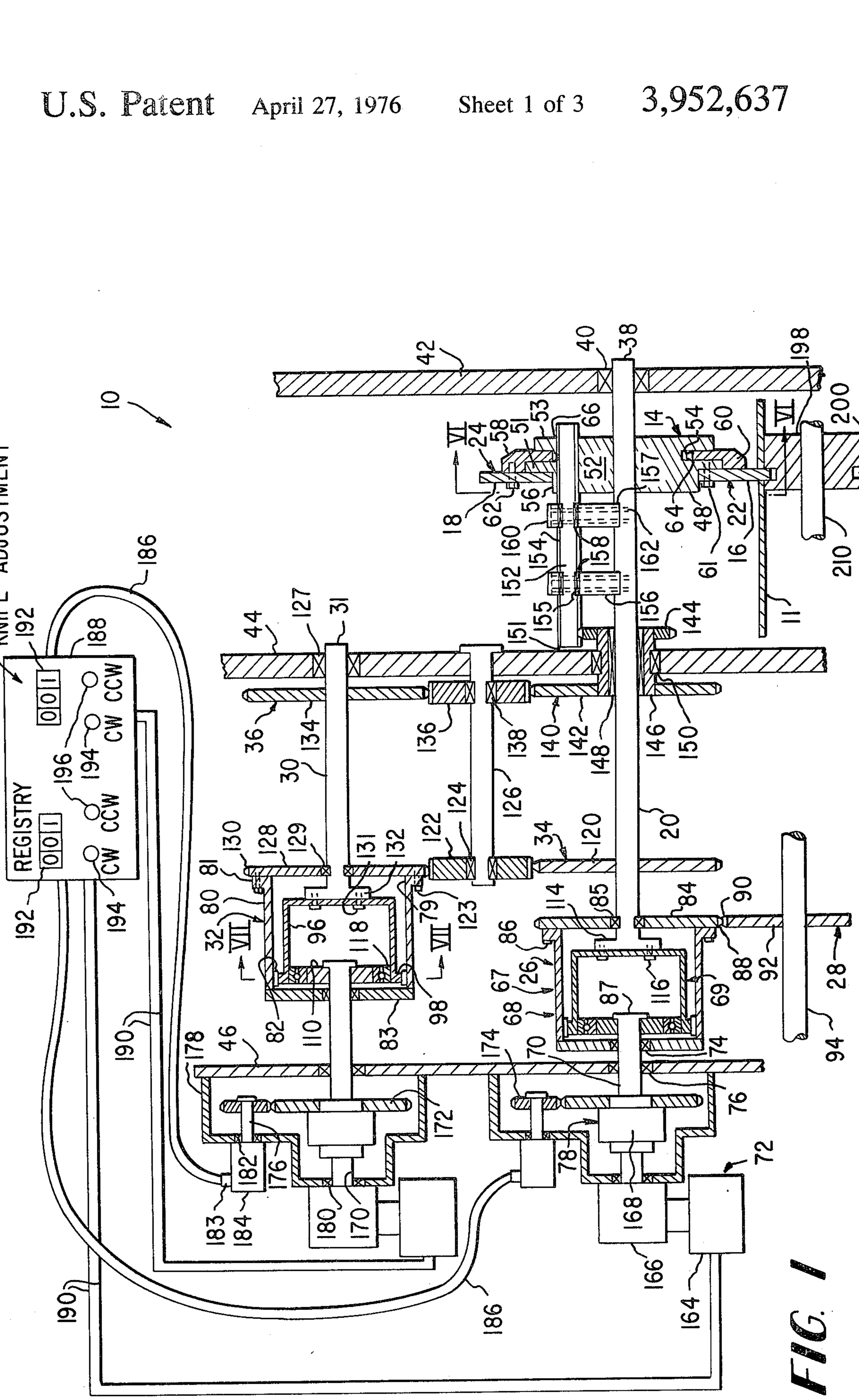


[57] **ABSTRACT**

Herein disclosed is an apparatus for changing the rotary position of a slotter member and for changing the relative position between fixed and movable knives mounted on the slotter member. The apparatus comprises a first rotatable shaft having at least one of the slotter members secured thereto; the slotter member having a fixed knife secured thereto and a movable knife mounted thereon; a driving apparatus; a first phase changing mechanism connected between the first shaft and the driving apparatus for rotating the slotter member; a second rotatable shaft spaced from the first shaft; a linking mechanism connected between the second shaft and the movable knife on the slotter member; a second phase changing mechanism connected between the first shaft and the second shaft for rotating the movable knife through the linking apparatus; and a selectively operable remote control apparatus for operating the first phase changing mechanism to selectively change the rotary position of the slotter member forward and backward with respect to the driving apparatus, the second phase changing mechanism and the linking mechanism maintaining the relative position of the fixed and movable knives during operation of the first phase changing mechanism, and for operating the second phase changing mechanism independently of the driving apparatus to selectively change the position of the movable knife forward and backward relative to the position of the fixed knife.


**16 Claims, 7 Drawing Figures**




KNIFE ADJUSTMENT
REGISTRY
CW CCW
CW CCW
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192
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196
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190
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127
31
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134
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VII
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110
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164

FIG. 1

FIG. 2

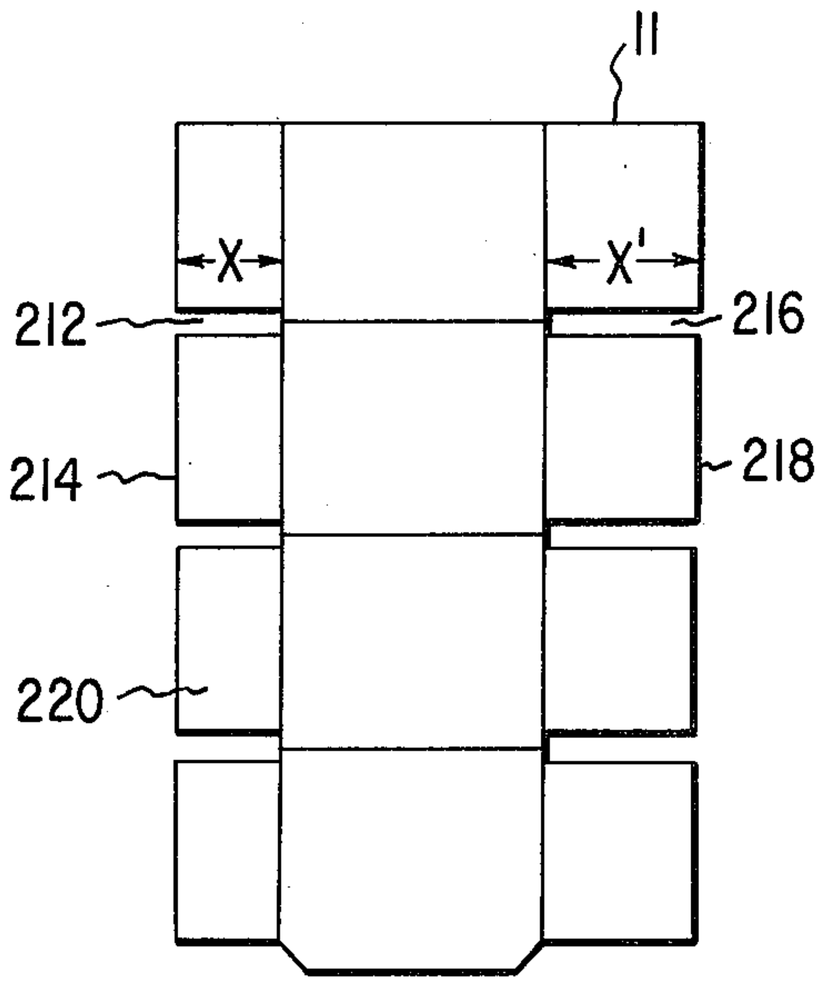
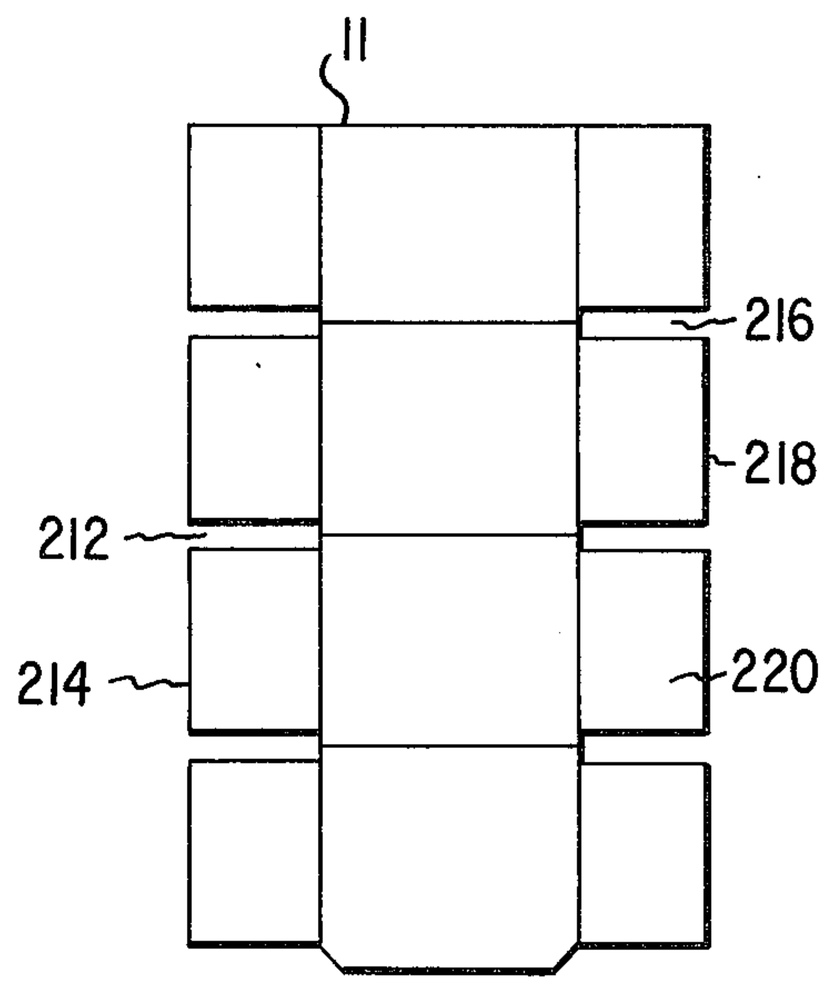



FIG. 3




BLANK

TRAVEL

FIG. 4

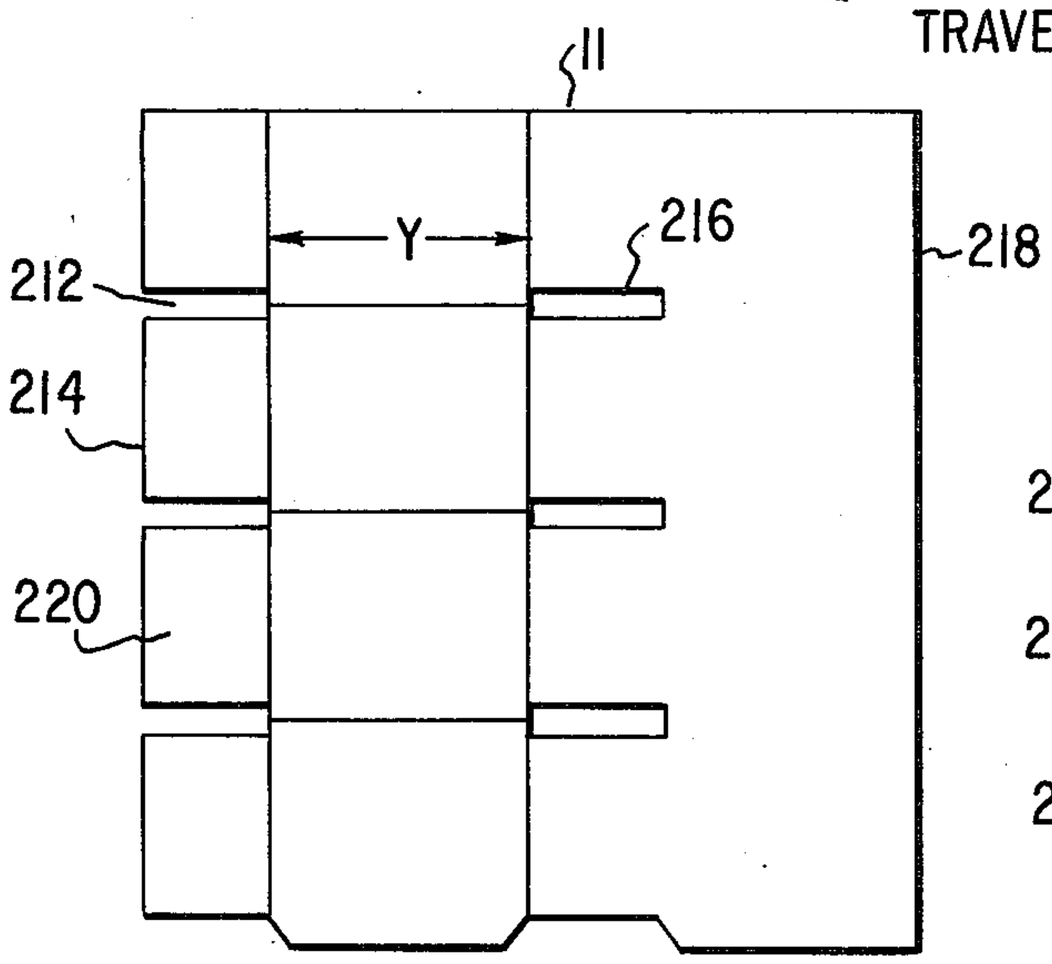
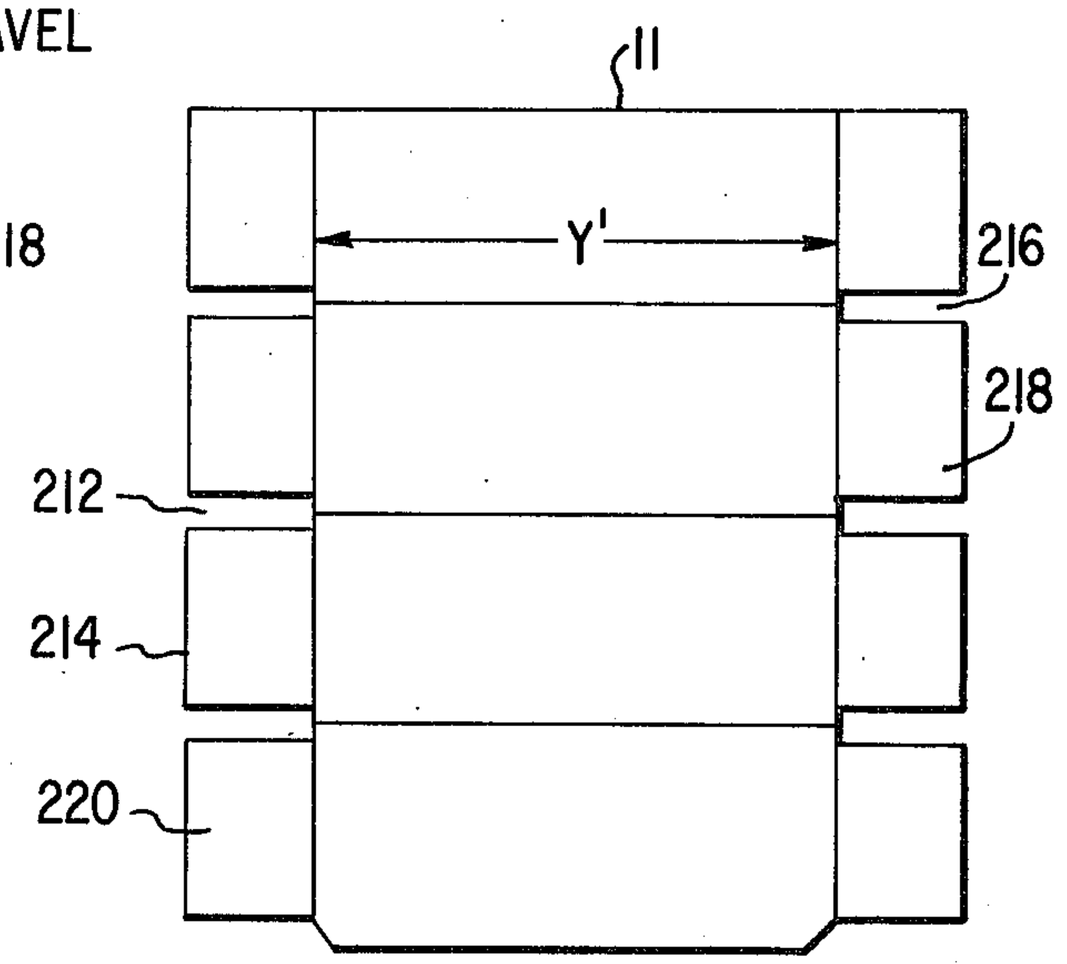



FIG. 5



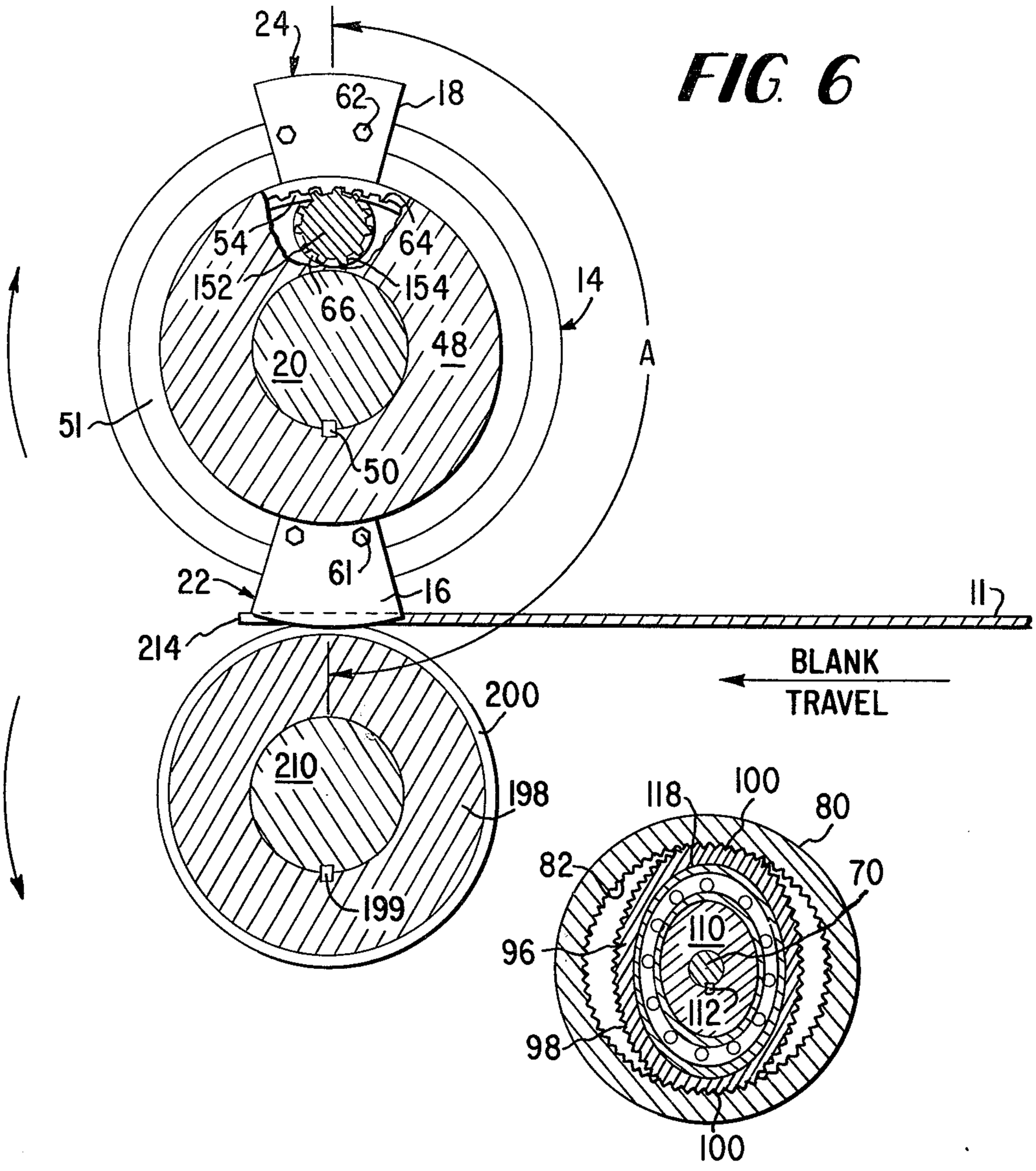

24
62
18
54
64
152
154
66
14
48
20
A
51
50
61
22
16
11
214
BLANK
TRAVEL
200
210
198
199
118
100
80
82
70
110
96
112
98
100

FIG. 6

FIG. 7

# APPARATUS FOR CHANGING THE ROTARY POSITION OF A SLOTTER MEMBER AND FOR CHANGING THE RELATIVE POSITION BETWEEN FIXED AND MOVABLE KNIVES ON THE SLOTTER MEMBER

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to cutting by a rotary tool having a segmented disc slitting or slotting tool and more particularly to an apparatus for changing the rotary position of a slotter member and for changing the relative position between fixed and movable knives on the slotter member.

2. Description of the Prior Art

In the slotting of corrugated paperboard blanks it is customary to use three rotary slotting members on a shaft which have a fixed slotting knife and a movable slotting knife thereon to cut slots in the paperboard blank to produce the flaps necessary for forming a corrugated box in which items are to be packed. To form the flaps on a corrugated box blank one knife on the slotting member is used to form the front slots on the leading edge of the box blank passing under the slotting member and the other knife is used to form the slots on the trailing edge of the box blank. To insure that the same size flaps are produced on both the leading edge of the box blank and the trailing edge of the box blank, it is necessary that one knife of the slotting member be in register with the leading edge of the blank as it passes beneath the slotting member. If the leading knife does not register with the leading edge of the box blank, slots of different lengths will be formed on the leading and trailing edge of the box blank forming flaps of different lengths. In addition, one knife on the slotting member is movable so that the angle between the fixed knife and the movable knife can be varied. This is necessary to insure that slots of equal length are formed at the leading and trailing edges of the box blank when a box blank of different size is to be run.

Heretofore, various apparatuses have been used to register one knife of the slotting member with the leading edge of a box blank passing thereunder, and for changing the angle between the movable knife with the fixed knife on the slotting member to produce flaps of equal length when it is desired to change the size of the box blank being run. Such an apparatus is shown in H. D. Ward, Jr. Pat. No. 3,067,643 which utilizes gearing arrangements to produce registery and angle changing between the knives. These gearing arrangements such as shown in the Ward patent are extremely complex, massive, and expensive to produce. Such arrangements require many different gears and gear arrangements and as such require precision manufacturing. These systems, because they use so many gears, are extremely large and bulky. Consequently, the cost of such gear arrangements are extremely high and these costs are passed on to the customer. An apparatus which is relatively inexpensive, that utilizes relatively few gears, and is able to be confined to a relatively small area is needed. Since the above gearing arrangements are extremely complex, bulky, and expensive, it is still quite common not to use any type of gearing arrangement for changing the angle between the movable knife and the fixed knife. Thus, when it is desired to form the flaps on a box blank of different size than previously



used, it is necessary to stop the operation and manually change the angle between the knives on each of the three slotting members. This method is not satisfactory since the operation of forming boxes must be stopped to change the knife angle which results in lost production time and because of human inaccuracies the angle between the knives on each slotter member may vary to a slight extent thus forming slots of different lengths on the trailing edge of the box blank which results in inferior boxes.

Another disadvantage in the Ward apparatus is that he uses hand-operated running registers to change the rotary position of the slotter member and to change the angle between the fixed and movable knives. Since the operator must take the time to adjust the registry by hand, it takes him away from his other duties and the master control panel that is used to indicate the status of other box making operations. In addition, Ward uses a control shaft external to the slotter heads and separate adjusting gears to change the knife angles on each slotter head. Thus, each adjusting gear must be individually adjusted by hand to the proper position to insure the same angle change is applied to each slotter member. Further, Ward uses the registry changing mechanism on one side of the slotter-scorer apparatus and the knife angle changing mechanism on the other side of the slotter-scorer apparatus. Thus, the machine operator must walk all the way around the machine each time he desires to make a change for each operation.

## SUMMARY OF THE INVENTION

The present invention overcomes the complexity, massiveness, and expensiveness of prior art devices by utilizing harmonic drive principles in combination with a minimum number of gears. By utilizing harmonic drive principles, the registration and angle changing can be accomplished while the slotting operations continue in operation. Further it provides an automatic means to register one knife of the slotting member with the leading edge of the paperboard box blank passing thereunder and for changing the angel between the movable knife and the fixed knife to form slots of equal length when it is desired to run various size paperboard box blanks. By providing an automatic means to make the desired changes the operator can remain at the master control panel and make the changes while continually maintaining a constant watch on the other box making operations. In addition, it provides that both the registry mechanism and the angle changing mechanism be on the same side of the machine so if work needs to be done on them the operator need not waste time walking around the machine. In addition, this invention provides a splined control shaft internally mounted in the slotter member which eliminates the need for adjusting gears.

This invention therefore provides an apparatus for automatically changing the rotary position of a slotter member and for changing the relative position between a fixed knife and a movable knife on the slotter member comprising; a first rotatable shaft means having at least one of the slotter members secured thereto; the slotter member having a fixed knife means secured thereto and a movable knife means mounted thereon; a drive means; a first phase changing means connected between the first shaft means and the drive means for rotating the slotter member; a second rotatable shaft means spaced from the first shaft means; a linking means connected between the second shaft means and

the movable knife means; a second phase changing means connected between the first shaft means and the second shaft means for rotating the movable knife means through the linking means; and a selectively operable remote control means for operating the first phase changing means to selectively change the rotary position of the slotter member forward and backward with respect to the drive means, the second phase changing means and the linking means maintaining the relative position of the fixed and movable knife means during operation of the first phase changing means, and for operating the second phase changing means independently of the drive means to selectively change the position of the movable knife means forward and backward relative to the position of the fixed knife means.

The above and further objects and novel features of the invention will appear more fully from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are not intended as a definition of the invention but are for the purpose of illustration only.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like parts are marked alike:

FIG. **1** is an end elevation in cross section of the apparatus of the present invention;

FIG. **2** is a top view of a paperboard box blank showing slots of different lengths on the leading and trailing edge thereof which results from nonregistration between the leading edge of the box blank and the slotter member of FIG. **1**;

FIG. **3** is a top view of the box blank of FIG. **2** showing slots of equal length formed on the leading and trailing edge thereof when the slotter member is in register with the leading edge of the box blank;

FIG. **4** is a top view of a box blank of greater size than the box blank shown in FIGS. **2** and **3** showing the orientation of the slots made by the slotter member of FIG. **1** when the angle between the slotting knives is that which produces proper slots in a box blank of the size shown in FIG. **3**;

FIG. **5** is a top view of the box blank of FIG. **4** showing the slot orientation on the leading and trailing edge of the box blank when the angle between the knives of the slotter member of FIG. **1** has been changed to accommodate the larger size box blank.

FIG. **6** is a cross sectional view of the slotter member of FIG. **1** taken along the lines VI—VI and showing the connection between the linking mechanism of FIG. **1** and the movable knife means on the slotter member; and

FIG. **7** is an enlarged cross sectional view of the harmonic drive unit of FIG. **1** taken along the lines VII—VII showing the elliptical deformation of the flexible gear member.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Box blanks manufactured by a conventional corrugator. The box blanks are then stacked and a stack of box blanks is placed on a feed table of a conventional slotter-scorer finishing machine. Conventionally, the slotter-scorer machine feeds each box blank at the predetermined speed through the slotter-scorer machine by a conventional driving mechanism. Ordinarily, each box blank is fed between three upper and lower slotting members for forming the flaps of which only one upper and lower slotting member is shown in FIG. **1** for simplicity. Knives penetrate blanks and pass through slots in the lower heads. The slotting members are spaced longitudinally along a shaft in accordance with the dimensions of the corrugated box blank to be formed. The slots made by the three upper and lower slotting members in the leading and trailing edges of the box blanks are of equal length and the length is determined by the size of the container to be formed. The slots define the flaps which form the top and bottom of the container. To form slots of equal length on the leading and trailing edges of the box blank it is mandatory that the slotting members be in exact registry with the leading edge and that the angle between the two slotting knives on the slotting members be adjusted to the correct angle when a box blank of different size is to be run. Conventionally, the fixed and movable knife means on the slotter member have a longer circumferential arc than the length of the slots formed in the box blank. Thus, the trailing edge of the lead knife must register with the point where the desired trailing edge of the front slot is to be formed and the front edge of the back knife must register with the point where the desired leading edge of the back slot is to be formed.



Referring to FIG. **1**, generally, the apparatus, denoted generally by numeral **10**, for changing the rotary position of a slotter member, denoted generally by numeral **14**, and for changing the relative position between a fixed knife means, denoted generally by numeral **22**, and a movable knife means, denoted generally by numeral **24**, on slotter member **14** is mounted on three spaced frames **42**, **44**, and **46** which is associated with a conventional slotter-scorer machine (not shown). Apparatus **10** generally comprises a first shaft means **20** rotatably secured to frames **42** and **44** and having at least one slotter member **14** secured thereto. Slotter member **14** has a fixed knife means **22** fixably secured to slotter member **14** and a movable knife means **24** movably mounted on slotter member **14**. A drive means, denoted generally by numeral **28** is used to drive a box blank **11** between slotter members **14** and **198** and to operate apparatus **10**. A first phase changing means, denoted generally by numeral **26**, is connected between first shaft means **20** and drive means **28** for rotating slotter member **14**. A second shaft means **30** is spaced from first shaft means **20** and is rotatably secured to frame **44**. A linking means, denoted generally by numeral **36**, is connected between second shaft means **30** and movable knife means **24**. A second phase changing means, denoted generally by numeral **32**, is connected between first shaft means **20** and second shaft means **30** for rotating movable knife means **24** through linking means **36**. A selectively operable remote control means **188** is electrically connected to first and second phase changing means **26** and **32** respectively for operating first phase changing means **26** to selectively change the rotary position of slotter member **14** forward and backward with respect to drive means **28**, second phase changing means **32** and linking means **36** maintaining the relative position of fixed and movable knife means **22** and **24** during operation of first phase changing means **26**, and for operating second phase changing means **32** independently of drive means **28** to selectively change the position of movable knife means **24** forward and backward relative to the position of fixed knife means **22**.

It should be noted that in FIG. **1** the first phase changing means **26** and the second phase changing

means **32** are substantially identical. Therefore, those parts that are identical between the first phase changing means **26** and the second phase changing means **32** are marked alike. For clarity in FIG. **1**, the numbering of the parts that make up first phase changing means **26** and second phase changing means **32** are not duplicated between the two. However, where there is a difference between first phase changing means **26** and the second phase changing means **32** the individual parts are individually numbered.

More specifically, and referring to FIGS. **1, 6,** and **7,** apparatus **10** is mounted on three spaced frames **42, 44,** and **46** which are associated with a conventional slotter-scorer machine (not shown) used in a conventional box making plant. Although three frame members are shown in FIG. **1,** it should be understood that various arrangements and configurations may be used on which to mount apparatus **10** and still be within the scope of the invention.

One end of first shaft means **20** is rotatably mounted in a bearing **40** which is secured in side frame **42.** First shaft **20** is secured in side frame **42** at a position spaced above the path of advance of a box blank **11** passing between side frame **42** and center frame **44,** and extends transversely to the path of advance of box blank **11.** First shaft means **20** passes through center frame **44** and is rotatably mounted therein (to be explained later) and terminates in a flanged end **144** at a point spaced from center frame **44.**

Preferably, three slotter members **14** (only one shown in FIG. **1**) are secured to first shaft means **20** between center frame **44** and side frame **42** in any conventional manner such as by key **50** (FIG. **6**) so that when first shaft **20** rotates, slotter member **14** will also rotate. It should be understood that although three slotter members **14** are preferably secured to first shaft means **20,** any number of slotter members may be secured thereon to produce the desired box configuration. Referring to FIGS. **1** and **6,** slotter member **14** includes a fixed knife means **22** which is fixably secured to slotter member **14** and a movable knife means **24** movably mounted on slotter member **14.** Preferably, slotter member **14** includes a rigid annular plate **48** commonly called a slotter head which is rigidly secured to first shaft means **20** by key **50** as previously described. Rigid annular plate **48** has a pair of radially extending and circumferentially extending spaced flanges **51** and **53** on its outer surface defining a space **54** between flanges **51** and **53.** Annular plate **48** also includes a circumferentially extending shoulder portion **56,** between flange **51** and side **52.** Preferably, flange **51** extends radially outward a greater amount than outside flange **53.** Rigid annular plate **48** further includes an axially extending opening **66** therethrough and is radially spaced between the center of rigid annular plate **48** and circumferentially extending shoulder **56.** Preferably, axially extending opening **66** is located closer to shoulder portion **56** than to the center of rigid annular plate **48,** as shown in FIGS. **1** and **6.** Space **54** between flanges **51** and **53** radially extends inward to a point where it meets axially extending opening **66** as shown in FIG. **6.**

Fixed knife means **22** includes a fixed slotter knife **16** which is seated on shoulder portion **56** and is rigidly secured to flange **51** by bolts **61.** Movable knife means **24** includes an annular ring **58** having inwardly extending gear teeth **64** on its inner surface which fits within space **54** and gear teeth **64** radially extend inward into axially extending opening **66.** Annular ring **58** further includes an axially extending flange **60** which slideably rests upon the top of flange **51.** Thus, annular ring **58** is free to move about flange **51.** Movable knife means **24** further includes a slotter knife **18** which is seated on shoulder **56** and is similar in construction to fixed slotter knife **16** and is secured to flange **60** of annular ring **58** by bolts **62.** Thus, when annular ring **68** moves within space **54** between flanges **51** and **53** movable knife **18** will also move about the circumference of rigid annular plate **48.**

Referring to FIG. **1,** first phase changing means **26** includes a harmonic drive means, denoted generally by numeral **68,** having an input means, denoted generally by numeral **67,** driven by drive means **28** and an output means, denoted generally by numeral **69,** connected to first shaft means **20;** a shaft connector means **70** is connected to output means **69** of harmonic drive means **68** and is in substantial alignment with first shaft means **20;** and a motor means, denoted generally by numeral **72,** is connected to one end of shaft connector means **70** so that upon energization of motor means **72** shaft connector means **70** rotates energizing harmonic drive means **68** for changing the phase relationship between drive means **28** and first shaft means **20.** Shaft connector means **70** extends through frame **46** and is rotatably mounted in a bearing **76** secured to frame **46.** A similar harmonic drive as used in this invention is shown in Stewart U.S. Pat. No. 3,565,006.

Referring to FIGS. **1** and **7,** input means **67** of harmonic drive means **68** includes an annular rotatable housing **80** being open at one end **79.** Open end **79** has a radially outward extending flange **81.** The other end of housing **80** is closed by an annular plate **83** which is secured thereto such as by welding. Annular housing **80** further includes inwardly extending gear teeth **82** circumferentially extending around the inner surface thereof. An annular input gear **84** is rotatably mounted on a bearing **85** secured to first shaft means **20** and is rigidly secured to flange **81** of annular housing **80** by bolts **86.** Input gear **84** includes radially outward extending gear teeth **88** for meshing with external gear teeth **90** on a driving gear **92** of first drive means **28** thereby imparting rotary motion to housing member **80** upon rotation of driving gear **92.** Driving gear **92** is rigidly secured such as by keying (not shown) to a shaft **94** which is connected to the conventional main drive train (not shown) of the slotter-scorer machine (not shown). The drive means **28** advances box blank **11** through the slotter-scorer apparatus, and at the same time drives slotter member **14.**

Referring again to FIGS. **1** and **7,** output means **69** of harmonic drive means **68** includes a circular flexible output gear **96** having a smaller diameter than the inner diameter of housing **80** and is nestled within housing **80.** One end of flexible gear **96** is open and faces the closed end of housing **80** and the other end is closed and faces open end **79** of housing **80.** The closed end of flexible gear **96** is secured to flanged end **114** of first shaft means **20** by bolts **116.** The open end of flexible gear **96** includes radially extending gear teeth **98** circumferentially extending around the outer surface thereof. Shaft connector means **70** extends through annular plate **83** of housing member **80** and is rotatably mounted in a bearing **74** secured to annular plate **83.** End **87** of shaft connector means **70** extends into the interior of flexible gear **96.** An elliptical phase generator **110** is secured to end **87** of shaft connector means

70 such as by key 112 (FIG. 7). An elliptical roller bearing 118 is secured on the outer circumference of elliptical phase generator 110 such as by a press fit. Elliptical roller bearing 118 deforms flexible gear 96 into an elliptical configuration so that external gear teeth 98 of flexible gear 96 are in meshing engagement with internal gear teeth 82 of housing 80 at substantially two points 100 (FIG. 7) opposite the lobes of elliptical phase generator 110. The theory behind the operation of harmonic drive means 68 which changes the phase relationship between outer housing 80 and flexible gear 96 and consequently changes the phase relationship between driving gear 92 and slotter member 14 is fully described and explained in a brochure published by the Harmonic Drive Division of United Shoe Machinery Corp., Balch Street, Beverly, Massachusetts 01915, Form No. 5033 and will not be further described herein except where necessary in explaining the operation of apparatus 10.

Referring to FIG. 1, motor means 72 includes a conventional electrical motor 164 which is capable of rotating in either the clockwise or counter clockwise direction. Motor 164 is electrically connected to remote control panel 188 through a pair of electrical wires 190. A gear reducer mechanism 166 is connected between motor 164 and connector shaft 170. Gear reducer 166 rotates shaft 170, coupling 168, shaft connector means 70, and phase generator 110 at a slower rotational speed than motor 164 so that very small adjustments in registration can be made.

Referring to FIG. 1, first phase changing means 26 further includes a readout indicator means, denoted generally by numeral 78, which is connected between shaft connector means 70 and remote control panel 188 for indicating the difference in length required to bring slotter member 14 into register with the leading edge 214 (FIG. 3) of box blank 11. Readout indicator means 78 includes a conventional flexible gear coupling 168 connected between the end of shaft connector means 70 and motor means 72. Coupling 168 is connected to motor means 72 by a shaft 170. A large gear 172 is connected to coupling 168 such as by keying (not shown). A second smaller gear 174 is in meshing engagement with larger gear 172, and gear 174 is connected to a shaft 168 such as by keying (not shown). A housing 178 is secured around coupling 168, gear 172, and gear 174. Housing 178 is secured to frame 46 such as by welding. Shaft 170 from coupling 168 extends through housing 178 and is rotatably mounted in a bearing 180 secured to housing 178 and shaft 176 secured to gear 174 extends through housing 178 and is rotatably mounted in a bearing 182 secured to housing 178. A gear adaptor 184 is secured to housing 178 such as by bolting (not shown) so shaft 176 extends therethrough into a gearing arrangement for imparting a 90 degree change in direction through an adaptor 183. A flexible shaft 168 is connected at one end to adaptor 183 and is connected at the other end to a digital read out odometer 192 which is mounted on the registry side of remote control panel 188. The operation and function of control panel 188 will be described in detail later.

Referring to FIG. 1, second shaft means 30 is rotatably mounted at end 31 in a bearing 127 secured in frame 44. Second shaft means 30 axially extends from frame 44 parallel to first shaft means 20 and terminates in a radially extending flange 132 at the other end.

Referring to FIGS. 1 and 7, second phase changing means 32 is substantially identical to first phase changing means 26 and includes a primary input means 34 driven by first shaft means 34; a harmonic drive means 68 having an input means 67 driven by primary input means 34 and an output means 69 connected to second shaft means 30; a shaft connector means 70 connected to output means 69 of harmonic drive means 68 in substantial alignment with second shaft 30; and a motor means 72 connected to shaft connector means 70 so that upon energization of motor means 72 shaft connector means 70 rotates for energizing output means 69 of harmonic drive means 68 for changing the angular relationship between fixed and movable knife means 22 and 24 respectively (FIG. 6). Shaft connector means 70 extends through frame 46 and is rotatably mounted in bearing 76 secured to frame 46. It further includes a readout indicator means 78 which is connected through a flexible shaft 186 to an odometer type digital readout 192 on the knife adjustment side of remote control panel 188. In addition, motor 164 is electrically connected to remote control panel 188 by a pair of electrical wires 190. Since second phase changing means 32 is substantially identical to first phase changing means 26, second phase changing means 32 will not be further described except where differences occur.

The first difference between first phase changing means 26 and second phase changing means 32 is that second phase changing means includes primary input means 34. Referring to FIG. 1, primary input means 34 includes a first gear 120 axially spaced from input gear 84 and is rigidly secured to first shaft means 20 such as by keying (not shown). A second gear 122 is in meshing engagement with first gear 120 and is rotatably mounted in a bearing 124 secured to a shaft 126. Shaft 126 is rigidly secured to frame 44 and extends parallel to first shaft means 20 and second shaft means 30.

Harmonic drive means 68 of second phase changing means 32 is identical to harmonic drive means 68 of first phase changing means 26 except that harmonic drive means 68 includes an annular input gear 128 instead of input gear 84 as shown for the first phase changing means 26. Input gear 128 is rotatably mounted in a bearing 129 secured to second shaft means 30 and is rigidly secured to flange 81 of housing 80 of harmonic drive means 68 by bolts 123. Input gear 128 includes outwardly extending gear teeth 130 which are in meshing engagement with second gear 122 of primary input means 34. In addition, flexible gear 96 of harmonic drive means 68 is secured to flange 132 of second shaft means 30 by bolts 131. Thus, when first shaft means 20 is rotated, second shaft means 30 is also rotated through primary input means 34 and harmonic drive means 68 of second phase changing means 32.

Referring to FIG. 1, linking means 36 includes a first gear 134 axially spaced from gear 128 and rigidly secured to second shaft means 30 such as by keying (not shown). A second gear 136 is in meshing engagement with first gear 134 and is rotatably mounted in a bearing 138 secured to shaft 126. A third gear means, denoted generally by numeral 140, is rotatably mounted on first shaft means 20 by a bearing 148. Third gear means 140 is preferably a compound gear which includes an input gear 142 in meshing engagement with second gear 136; an output gear 144 axially spaced from input gear 142; and a sleeve means 146 rigidly connected between input gear 142 and output gear 144

such as by keying (not shown) or by a press fit. Sleeve **146** is rotatably mounted on first shaft means **20** by gearing **148** and is rotatably mounted in a bearing **150** secured in frame **44** so that input gear **142** is on one side of frame **44** and output gear is on the other side of frame **44.**

Referring now to FIGS. **1** and **6,** linking means **36** further includes a splined shaft means **152** having external gear teeth **154** and having an axial length sufficient to span between output gear **144** and the desired number of slotter members **14.** In addition, the splined shaft **152** permits the slotter heads **14** to be positioned along shaft **20** to provide the desired distances between the slots in the box blank **11** by merely unlocking the heads. Splined shaft means **152** is radially spaced from and extends parallel to first shaft means **20** and transversely to the path of advance of box blank **11.** One end **151** of splined shaft means **152** is in meshing engagement with output gear **144** and the remaining length of splined shaft means **152** extends through opening **66** in each slotter member **14,** so that spline teeth **154** of splined shaft means **152** is in meshing engagement with the internal extending gear teeth **64** of annular ring **58** of movable knife means **24.** Splined shaft means **152** is rotatably secured to first shaft means **20** by a plurality of platforms **156** which are seated in notched portions **157** of first shaft means **20.** Platform **156** radially extends outwardly so that a narrowed portion **155** on splined shaft means **152** rests within a cut out portion in the top of platform **156.** The top portion of platform **156** contains a half bushing **158** so that narrowed portion **155** of spline gear **152** may rotate about bushing **158.** A top **160** also containing a cut out portion and a half bushing **158** is secured to platform **156** over notched portion **155** of splined shaft means **152** by bolts **162** which extend from top **160** through platform **156** and into first shaft means **20.** Thus, splined shaft means **152** is secured to first shaft means **20** so that when first shaft means **20** rotates splined shaft means **152** will also rotate with first shaft means **20,** however, because splined shaft means **152** is rotatably mounted in platform **156,** splined shaft means **152** is also able to rotate about its own axis. Therefore, second phase changing means **32** is connected to movable knife means **24** through linking means **36.** In particular, splined gear teeth **154** of splined shaft means **152** are in meshing engagement with gear teeth **64** of annular ring **58** of movable knife means **24.**

## OPERATION

Referring to FIGS. **1, 2, 3, 4, 5, 6,** and **7,** when it is desired to form the flaps **220** (see FIGS. **2, 3, 4,** and **5**) on a box blank **11,** the operator places a stack of box blanks on a conventional feed table of a conventional slotter-scorer machine (not shown). The operator energizes the main drive train of the slotter-scorer apparatus which operates a conveyor system from the feed table through the slotter-scorer machine at a predetermined speed. The feed table feeds a single box blank **11** at a time from the stack so that a box blank **11** is conveyed through the slotter-scorer machine between frame **42** and frame **44.** In addition, the main drive train also energizes drive means **28** which rotates shaft **94** and drive gear **92.** Box blank **11** travels beneath first shaft means **20** and between upper and lower slotter members **14** and **198** (FIGS. **1** and **6**). Lower slotter members **198** are rigidly secured to a shaft **210** such as by key **199** and is connected to the main drive train of the slotter-scorer machine. Lower slotter member **198** and shaft **210** are parallel to and in alignment below first shaft means **20** and upper slotter member **14.** Lower slotter member **198** is in alignment with knives **16** and **18** on slotter member **14.** In addition, lower slotter member **198** contains a circumferential extending slot **200** in its outer periphery for receiving of knives **16** and **18** as they pass through box blank **11.**

For illustration purposes only, box blank **11** will be depicted as traveling in the direction shown by the arrow in FIGS. **2, 3, 4** and **5** and knife **16** of fixed knife means **22** will be depicted as making slots **212** on the leading edge **214** of box blank **11** and knife **18** of movable knife means **24** will be depicted as making slots **216** in the trailing edge of box blank **11.** However, it should be understood that either knives **16** or **18** can make slots **212** or **216.** As box blank **11** travels between upper and lower slotter members **14** and **198,** leading knife **16** forms a slot **212** in the leading edge **214** of box blank **11** and trailing knife **18** forms a slot **216** in the trailing edge **218** of box blank **11** as shown in FIGS. **1, 3,** and **5**

Three phases in the operation of apparatus **10** will now be described. The first operation will be the normal running of a box blank **11** though the slotter-scorer machine when registry of slotter member **14** is not necessary and when a knife adjustment between the fixed knife means **22** and the movable knife means **24** is not necessary. In the first operation, box blank **11** will be formed with flaps **220** as shown in FIGS. **3** and **5.** The second operation will be where knife **16** of slotter member **14** is out of registry with the leading edge of box blank **11** as shown in FIG. **2.** The second operation will describe the manner in which trailing edge of leading knife **16** of slotter member **14** is brought into register with the point where the desired trailing edge of slot **212** is to be formed and where the front edge of knife **18** must register with the point where the desired leading edge of slot **216** is to be formed so that a box blank **11** of proper configuration is formed as shown in FIG. **3.** The third operation will be the operation of changing the angle A (FIG. **6**) between the fixed knife means **22** and the movable knife means **24** when a box blank of larger or smaller size is desired to be run such as shown in FIG. **4** to form a box blank **11** of proper slot configuration as shown in FIG. **5.**

When using harmonic drive means such as that used with apparatus **10** it is customary to have the flexible gear contain a less number of gear teeth than the number of gear teeth surrounding the inner periphery of the annular housing. The flexible gear will therefore rotate at a slightly faster angular velocity than the housing. To insure that slotter member **14** rotates at the same angular velocity as slotter member **198** and first drive means **28** and to insure proper registration during normal operation, the number of gear teeth in each of the gears throughout apparatus **10** must be properly varied.

For illustration purposes, the various gears used in apparatus **10** will be described as having a specific number of gear teeth to illustrate the tooth configuration and relationship between the various gears for continuous proper registration. It should be understood, however, that although a specific number of gear teeth is illustrated in the description of the operation any tooth configuration of the various gears may be used as long as in the end result slotter member **14** is rotating at the same speed as slotter member **198.**

During normal operation of the slotter scorer machine in which apparatus **10** is used, phase generator **110** of first phase changing means **26** and second phase changing means **32** are held stationery so that the lobes of phase generator **110** maintain the same orientation with respect to annular housing **80.** Phase generator **110** is held stationery by any conventional braking mechanism in gear reducer **166** so that when motor **164** is de-energized, gear reducer **166** will be braked thereby preventing rotation of shaft **170,** coupling **168,** shaft connector means **70,** and consequently phase generator **110** and elliptical roller bearing **118.** When phase generator **110** is held stationary, flexible gear **96** rotates about roller bearing **118** when annular housing **80** is rotated due to the meshing engagement of gear teeth **98** and **82** respectively at the two contact points **100.**

Referring to FIGS. **1, 6** and **7,** during the normal operation of the slotter-scorer machine, shaft **94** is rotated by the main drive train of the slotter-scorer machine and is driven at the desired machine speed. Shaft **94** rotates drive gear **92** which for illustration purposes will contain **96** gear teeth **90.** The **96** gear teeth **90** of drive gear **92** are in meshing engagement with gear teeth **88** of input gear **84.** Input gear **84** contains **97** gear teeth so that input gear **84** will rotate at a slightly slower angular velocity than drive gear **92.** Input gear **84** is rotatably mounted on bearing **85** secured to first shaft means **20** so that input gear **84** will rotate about first shaft means **20.** Input gear **84** rotates annular housing **80** of harmonic drive means **68** of first phase changing means **26.** Outer annular housing **80** also contains **97** gear teeth **82** which are in meshing engagement with gear teeth **98** of flexible gear **96** having **96** gear teeth at essentially two points **100.** Thus annular housing **80** which is in meshing engagement with gear teeth **98** of flexible gear **96** will rotate flexible gear **96** at a slightly faster angular velocity than the angular velocity of annular housing **80.** Since flexible gear **96** contains **96** gear teeth and drive gear **92** also contains **96** gear teeth, flexible gear **96** and drive gear **92** will rotate at the same angular velocity. Thus, first shaft means **20** will also rotate at the same angular velocity as drive gear **92** since it is connected to flexible gear **96** and since slotter member **14** is rigidly secured to first shaft means **20** slotter member **14** will also rotate at the same angular velocity as first drive gear **92** and slotter member **198.**

Since movable knife means **24** is rotatably mounted on slotter member **14,** movable knife means **24** must also rotate at the same angular velocity as fixed knife means **22** to maintain angle A between fixed knife means **22** and movable knife means **24.** First gear **120** of primary input means **34** is rigidly secured to first shaft means **20** and thus rotates at the same angular velocity as first shaft means **20.** First gear **120** contains **96** gear teeth which is the same as first drive gear **92.** Second gear **122** which is rotatably mounted on shaft **126** is merely an idler gear and it doesn't matter how many teeth it has, the ratio is determined by the number of teeth of gear **120** and gear **128.** Second gear **122** is in meshing engagement with input gear **128** which is rotatably mounted on bearing **129** secured to second shaft means **30** and is connected to outer housing **80** of harmonic drive means **26** of second phase changing means **32.** Input gear **128** contains **97** gear teeth **130** so that it rotates at a slightly slower angular velocity than gear **120.** Housing **80** of harmonic drive means **26** of second phase changing means **32** has **97** gear teeth **82** on its inner periphery which are in meshing engagement with **96** gear teeth **98** on flexible gear **96** at substantially two contact points **100.** Since flexible gear **96** is rigidly connected by bolts **131** to second shaft means **30,** flexible gear **96** which has **96** gear teeth will rotate second shaft means **30** at a slightly faster angular velocity than housing **80** and since proper gear teeth configuration has been maintained, second shaft means **30** will rotate at the same angular velocity as first shaft means **20.**

First gear **134** of linking means **36** contains **96** gear teeth and is rigidly connected to first shaft means **30.** Second gear **136** is an idler gear and it doesn't matter how many teeth it has, the ratio is determined by the number of teeth of gear **134** and **142** and is rotatably mounted on bearing **138** secured to shaft **126** and is in meshing engagement with first gear **134.** Input gear **142** also contains **96** gear teeth and is in meshing engagement with second gear **136.** Since third gear means **140** is a compound gear and is rotatably mounted on first shaft means **20** by bearing **148** and rotatably mounted in bearing **150** secured to frame **44,** input gear **142,** sleeve **146,** and first shaft means **20** are rotating at the same angular velocity. Therefore sleeve **146** is not rotating about first shaft means **20.** Output gear **144** which is secured to sleeve **146** also contains **96** gear teeth and is rotating at the same angular velocity as first shaft means **20.** In order to insure that movable knife means **24** does not move relative to fixed knife means **22,** splined gear means **152** will contain **18** gear teeth **154** which are in meshing engagement with the **96** gear teeth of output gear **144** and with gear teeth **64** of annular ring **58** on which knife **18** is mounted. In this configuration, annular ring **58** will contain **132** gear teeth **64.** Since third gear means **140** is not moving relative to first shaft means **20,** no rotational movement of splined gear means **152** about its own axis will occur. However, splined gear means **152** will rotate with first shaft means **20** at the same angular velocity as first shaft means **20** since it is secured to first shaft means **20** by platforms **156.** Consequently, movable knife means **24** will have the same angular velocity about the axis of shaft **20** as fixed knife means **22** and angle A (FIG. **6**) will be maintained.

Referring to FIGS. **2** and **3,** when it is desired to change the registry between knife **16** of slotter member **14** and leading edge **214** of box blank **11** the following operation is run. As shown in FIG. **2,** slotting member **14** will be out of registry with the leading edge **214** of box blank **11** when slot **212** in the leading edge **214** of box blank **11** has a different length X as compared to length X′ of slot **216** in the trailing edge **218** of box blank **11.** Although as shown in FIG. **2** slot **212** in the leading edge **214** is of a shorter length than slot **216** in the trailing edge **218,** it should be understood that the length X of slot **212** may be longer than the length X′ of slot **216.** For illustration purposes only, slot **212** is shown at a shorter length X than slot **216.** When registry is needed, the operator measures the difference between the length X of slot **212** and the length X′ of slot **216.** The difference in slot length X and X′ divided by two is the amount that slotter member **14** must be retarded or speeded up relative to drive gear **92** which corresponds to blank velocity to bring knife **16** into registry with leading edge **214.** The angular velocity of slotter member **14** must be temporarily changed while maintaining the proper angular velocity of slotter mem-

ber **198** to bring the rotary position of knife **16** into registry with edge **214** of box blank **11.** To termorarily change the angular velocity of slotter member **14** the operator activates motor **164** of motor means **72** of first phase changing means **26** by pushing starter buttons **194** or **196** on the registry side of control panel **188.** For illustration purposes only, it will be assumed that housing member **80** of harmonic drive means **68** rotates in the clockwise direction looking from left to right in FIG. **1.** If slot length **212** is to be increased, slotter member **14** must be retarded so the operator depresses the counter clockwise button **196** on the registry side of control panel **188** which activates motor **164** in the counterclockwise direction; however, if the length of slot **212** is to be decreased, the clockwise button **194** on the registry side of control panel **188** will be depressed which rotates motor **164** in a clockwise direction. As shown in FIG. **2** the slot length X of slot **212** needs to be increased, therefore the operator will depress the counter clockwise button **196** on the registry side of control panel **188.** This activates motor **164** in the counter clockwise direction which rotates gear reducer **166** in the counter clockwise direction. Reducer **166** rotates shaft **170,** coupling **168,** and shaft connector means **70,** in the counter clockwise direction at a reduced angular velocity so that small changes in length can be measured. Referring to FIG. **7,** since shaft connector means **70** is rotating in the counter clockwise direction and phase generator **110** is rigidly secured to shaft connector means **70,** phase generator **110,** and roller bearing **118** secured to phase generator **110** will rotate counter clockwise. This counter clockwise rotation of phase generator **110** will deflect flexible gear **96** so that the two points of contact **100** between gear teeth **98** of flexible gear **96** and gear teeth **82** of outer housing **80** will move counter clockwise to give a different point of orientation. Thus, it can be seen that flexible gear **96** is rotating in the clockwise direction at a lesser angular velocity than housing **80** during the counter clockwise rotation of phase generator **110.** Since flexible gear **96** is connected to slotter member **14** through first shaft means **20,** slotter member **14** will be rotating clockwise at a slower angular velocity than slotter member **198** and consequently box blank **11.** This slower clockwise angular velocity of slotter member **14** will bring more of knife **16** in contact with box blank **11** which will increase the length of slot **212.**

To determine when the correct slot length is reached to make the length X of slot **212** in the leading edge **214** the same length as X′ of slot **216** on the trailing edge **218** of box blank **11,** the operator reads the difference in length X and X′ divided by two on a digital read out odometer window **192** on the registry side of control panel **188.** Since shaft connector means **70** and shaft **170** are connected to coupling **168,** coupling **168** is rotated counter clockwise at the same angular velocity as phase generator **110.** Gear **172** is rotated by coupling **168** and gear **174** which is in meshing engagement with second gear **172** rotates shaft **176** which rotates gear adaptor **184.** Flexible shaft **186** is connected between adaptor **183** and a convention digital readout odometer **192** on the registry side of control panel **188.** Thus the rotation of flexible shaft **186** rotates digital readout odometer **192** so that the counter clockwise rotational distance moved by phase generator **110** is read in the window of the odometer readout **192.** When the difference in length between X and X′ divided by two is shown in the odometer window **192** knife **16** will be in registry with the leading edge **214** and the operator then deactivates motor **164** which sets the brake in gear reducer **166** which stops further counter clockwise rotation of phase generator **110.** With phase generator **110** in its stationery position, first shaft means **20** and, consequently slotter member **14,** will again be rotating at the same angular velocity as first drive gear **92** and slotter member **198.** Thus, box blank **11** as shown in FIG. **3** will once again have slots of equal length in the leading and trailing edges **214** and **216.**

When the operator desires to process box blanks of different size, as shown in FIGS. **4** and **5,** the angle A (FIG. **6**) between the fixed knife means **22** and the movable knife means **24** must be changed to increase or decrease the arc length subtended by angle A to increase or decrease the distance between slots **212** and **216.** This is to insure that proper slot orientation is maintained to form proper flaps **220** on the new box blanks. For illustration purposes, as shown in FIGS. **4** and **5,** a box blank **11** of larger size is to be run. However, it should be understood that either a smaller box blank or a larger box blank may be run and if a smaller box blank **11** is to be run the angle A between the fixed knife means **22** and the movable knife means **24** will be decreased to decrease the arc length while as shown in FIGS. **4** and **5** if a larger box blank **11** is to be run angle A must be increased to increase the arc length to increase the distance between slots **212** and **216.**

Referring to FIGS. **4** and **5,** to change angle A and consequently the arc length subtended by angle A the operator measures the distance Y between slots **212** on leading edge **214** of box blank **11** and slot **216** on trailing edge **218** of box blank **11.** Then the operator determines the distance Y′ between slot **212** and slot **216** that is necessary to produce slots of equal length and equal configuration on the larger box blank **11** to be run. The operator then determines the difference between distance Y and Y′ and this difference is the increase in arc length subtended by angle A that is needed to give proper slot orientation to the larger box blank **11.** The difference in arc length subtended by angle A is read on control panel **188** through the odometer type digital readout **192** on the knife adjustment side of control panel **188.** The operator can thereby determine when the correct increase in arc length subtended by angle A has been reached.

Assuming for illustration purposes only that slotter member **14** as shown in FIGS. **1** and **6** is rotating in the clockwise direction and that the box blank **11** to be run is of larger size than previously run then the arc length subtended by angle A must be increased. Thus, relative to fixed knife means **22,** movable knife means **24** must temporarily be rotated counterclockwise. To increase angle A the operator depresses the clockwise button **194** on the knife adjustment side of control panel **188.** This activates motor **164** of second phase changing means **32** in the clockwise direction. Motor **164** rotates gear reducer **166,** shaft **170,** coupling **168,** shaft connector means **70,** and phase generator **110** in the clockwise direction.

Referring to FIG. **1,** the clockwise rotation of phase generator **110** rotates roller bearing **118** clockwise deforming flexible gear **96** and rotating the two points of contact **100** in the clockwise direction. This clockwise deflection of flexible gear **96** will increase the angular velocity of flexible gear **96** in the clockwise

direction. Since the angular velocity of flexible gear **96** is increased while the angular velocity of annular housing **80** stays the same as first shaft means **20,** second shaft means **30** will rotate at a greater angular velocity than first shaft means **20.** This increased angular velocity of second shaft means **30** in the clockwise direction is imparted to first gear **134** of linking means **36.** The clockwise rotation of first gear **134** rotates second gear **136** counter clockwise which rotates input gear **142,** sleeve **146,** and output gear **144** clockwise. Thus, compound gear **140** is rotating in the clockwise direction with an angular velocity greater than the angular velocity of first shaft means **20.** Since sleeve **146** and consequently output gear **144** are rotating clockwise at a greater angular velocity than the clockwise angular velocity of first shaft means **20,** splined shaft means **152** in meshing engagement with output gear **144** will rotate counter clockwise about its own axis as first shaft means **20** rotates splined shaft means **152** about the axis of first shaft means **20** since splined shaft means **152** is secured to first shaft means **20** by platforms **156.** This counter clockwise rotation of splined shaft means **152** about its own axis is imparted through its gears **154** to teeth **64** of angular ring **58,** and annular ring **58** will rotate in the clockwise direction at an angular velocity that is less than the angular velocity of fixed knife means **22.** Thus, relative to fixed knife means **22,** movable knife means **24** is rotating counter clockwise. This decrease in angular velocity of movable knife means **24** will cause angle A between fixed knife means **22** and movable knife means **24** to increase. Since angle A is increased, the arc length subtended by angle A is also increased.

Referring to FIGS. **1, 4,** and **5,** the difference between length Y and length Y′ is read on the digital odometer readout window **192** on the knife adjustment side of control panel **188.** The operation of the digital odometer readout indicator **192** on the knife adjustment side of control panel **188** is the same as that described for the registry side of control panel **188** will not be further described. When the correct arc length is read in window **192** the operator de-energizes motor **164** which stops and brakes gear reducer **166** which stops any further clockwise rotation of phase generator **110.** Thus, the new position of the two contact points **100** opposite the cam lobes of phase generator **110** are in a new position clockwise from the position that they were before. Once phase generator **110** stops rotating, apparatus **10** will be running in its normal operation wherein second shaft means **30** and first shaft means **20** are again rotating at the same angular velocity. When this occurs there will be no relative movement between fixed knife means **22** and movable knife means **24** thereby maintaining the correct angle A between them. When this occurs, box blank **11** as shown in FIG. **5** will have the correct slot orientation.

The operation for decreasing angle A is exactly the same as the operational described for increasing angle A except that the counter clockwise button **196** on the knife adjustment side of control panel **188** is depressed which operates everything in the opposite direction.

The foregoing has presented a novel apparatus used in conjunction with a conventional slotter-scorer machine for forming the flaps on corrugated box blanks so that the box blanks may be formed into boxes. The apparatus to be used presents a novel automatic means of changing the rotary position of the slotter member in relationship to the leading edge of the box blank passing thereunder to insure that the slots formed on the leading edge of the box blank are the same length as the slots formed in the trailing edge of the box blank. In addition, this apparatus presents a novel automatic means of changing the relative position between the fixed and movable knives on the slotter member to form the proper slot orientation when the size of the box blank being run is changed. Both operations are performed from a remote control panel without having to stop the operation of the machine or take the operators attention away from other operations in the box making operation. The complexity of the operation has been substantially reduced by the use of harmonic drive devices to place the knives in registry with the leading edge of the box blank and to change the angle between the fixed and movable knives. This allows the use of a minimum amount of gears between the harmonic drive devices and the slotter member. In addition, by using harmonic drive devices and a minimum amount of gearing, the expense of manufacturing such an apparatus is kept to a minimum. Further, the use of harmonic drive devices associated with the minimum amount of gearing allows for an overall smaller package as compared to prior art devices.

Accordingly, the invention having been described in its best embodiment and mode of operation that which is desired to be claimed by Letters Patent is:

**1.** Apparatus for changing the rotary position of a slotter member and for changing the relative position of fixed and movable knife means on said slotter member, comprising:

a first rotatable shaft means having at least one of said slotter members secured thereto;

said slotter member having a fixed knife means secured thereto and a movable knife means mounted thereon;

a drive means;

a first phase changing means connected between said first shaft means and said drive means for rotating said slotter member;

a second rotatable shaft means spaced from said first shaft means;

a linking means connected between said second shaft means and said movable knife means;

a second phase changing means connected between said first shaft means and said movable knife means through said linking means; and

a selectively operable remote control means for:

**1.** operating said first phase changing means to selectively change the rotary position of said slotter member forward and backward with respect to said drive means said second phase changing means and said linking means maintaining the relative position of said fixed and movable knife means during operation of said first phase changing means, and for

**2.** operating said second phase changing means independently of said drive means to selectively change the position of said movable knife means forward and backward relative to the position of said fixed knife means.

**2.** The apparatus of claim **1** wherein said movable knife means includes:

a movable annular ring means mounted on said slotter member;

a slotter knife rigidly secured to said annular ring means and extending beyond the outer circumference of said annular ring means; and

said annular ring means having inwardly extending gear teeth on its inner surface for rotation by a splined shaft means of said linking means.

**3.** The apparatus of claim **1** wherein said first phase changing means includes:

a harmonic drive means having an input means driven by said drive means and an output means connected to said first shaft means;

a shaft connector means connected to said output means and in substantial axial alignment with said first shaft means; and

a motor means connected to said shaft connector means so that upon energization of said motor means said shaft connector means rotates for energizing said output means to change the rotary position between said drive means and said first shaft means.

**4.** The apparatus of claim **3** further including a readout indicator means connected between said shaft connector means and said remote control means for indicating the rotary position of said slotter member in relation to the position of said drive means.

**5.** The apparatus of claim **3** wherein said input means of said harmonic drive means includes:

an annular rotatable housing member having internal gear teeth; and

an annular input gear secured to said housing member and having outwardly extending gear teeth for meshing with outwardly extending gear teeth on a driving gear of said drive means, thereby rotating said housing member upon rotation of said driving gear.

**6.** The apparatus of claim **5** wherein said output means of said harmonic drive means includes:

a flexible output gear housed within said housing member and secured to said first shaft means;

said flexible output gear being of smaller diameter than said housing member and having outwardly extending gear teeth;

an elliptical phase generator connected to said shaft connector means and housed within said flexible gear deforming said flexible gear to an elliptical shape so that said outwardly extending gear teeth are in meshing engagement with said internal gear teeth at two contact points; and

said elliptical phase generator adapted to deform said flexible gear forward and backward with respect to said housing member upon energization of said first phase changing means for changing the relative circumferential position of said two contact points,

thereby changing the phase relationship between said flexible gear and said housing member.

**7.** The apparatus of claim **1** wherein said second phase changing means includes:

a primary input means driven by said first shaft means;

a harmonic drive means having a secondary input means driven by said primary input means and an output means connected to said second shaft means;

a shaft connector means connected to said output means and in substantial alignment with said second shaft means; and

a motor means connected to said shaft connector means so that upon energization of said motor means said shaft connector means rotates for energizing said output means to change the angular relationship between said fixed and movable knife means.

**8.** The apparatus of claim **7** wherein said primary input means includes:

a first gear rigidly connected to said first shaft means;

a second gear in meshing engagement with said first gear and said secondary input means of said harmonic drive means; and

said second gear rotatably mounted on a shaft.

**9.** The apparatus of claim **7** further including a readout indicator means connected between said shaft connector means and said remote control means for indicating the angular distance between said fixed and movable knife means.

**10.** The apparatus of claim **7** wherein said secondary input means of said harmonic drive means includes:

an annular rotatable housing member having internal gear teeth; and

an annular input gear secured to said housing member and having outwardly extending gear teeth for meshing with a gear of said primary input means, thereby rotating said housing member upon rotation of said primary input means.

**11.** The apparatus of claim **10** wherein said output means of said harmonic drive means includes:

a flexible output gear housed within said housing member and secured to said second shaft means;

said flexible output gear being of smaller diameter than said housing member and having outwardly extending gear teeth;

an elliptical phase generator connected to said shaft connector and housed within said flexible gear deforming said flexible gear to an elliptical shape so that said outwardly extending gear teeth are in meshing engagement with said internal gear teeth at two contact points; and

said elliptical phase generator adapted to deform said flexible gear forward and backward with respect to said housing member upon energization of said second phase changing means for changing the relative circumferential position of said two contact points,

thereby changing the phase relationship between said flexible gear and said housing member.

**12.** The apparatus of claim **1** wherein said linking means includes;

a first gear connected to said second shaft means;

a second gear in meshing engagement with said first gear;

said second gear rotatably mounted on a shaft;

a third gear means rotatably mounted on said first shaft means;

said third gear means including,

an input gear in meshing engagement with said second gear,

an output gear axially spaced from said input gear, and

a sleeve means secured between said input and output gears;

a splined shaft means rotatably secured to said first shaft means; and

said splined shaft means having one end in meshing engagement with said output gear and having the other end in meshing engagement with gear teeth on said movable knife means,

whereby rotational motion is transferred from said second shaft means to said movable knife means.

13. The apparatus of claim 12 wherein said movable knife means includes:

a movable annular ring means mounted on said slotter member;

a slotter knife rigidly secured to said annular ring means and extending beyond the outer circumference of said annular ring means; and

said annular ring means having inwardly extending gear teeth on its inner surface in meshing engagement with the gear teeth on said splined shaft means.

14. An apparatus for registering a rotary slotter member with a corrugated box blank traveling through a box blank slotter-scorer machine and for changing the angle between a fixed knife means and a movable knife means on said slotter member to accommodate different size box blanks during operation of said machine without having to interupt operations, comprising:

a first rotatable shaft means spaced above the path of advance of said box blank traveling through said slotter-scorer machine;

said first shaft means rotatably secured to a frame means of said slotter-scorer machine and having at least one of said slotter members secured thereto for rotation above said box blank;

said slotter member having a fixed knife means secured to said slotter member and a movable knife means rotatably mounted on said slotter member;

a registry changing means connected between said first shaft means and a drive means for rotating said slotter member and for changing the phase relationship of said slotter member to the leading edge of said traveling box blank;

said drive means advancing said box blank through said slotter-scorer machine and connected to an input portion of said registry changing means;



a second rotatable shaft means spaced above said first shaft means and rotatably connected to said frame means;

a linking means connected between said second shaft means and said movable knife means;

a phase changing means connected between said first shaft means and said second shaft means for rotating said movable knife means; and

a selectively operable remote control means for:

1. operating said registry changing means to selectively change the rotary position of said fixed and movable knife means with respect to said drive means, said phase changing means and said linking means maintaining the relative position of said fixed and movable knife means during operation of said registry changing means, and for

2. operating said phase changing means independently of said drive means to selectively change the position of said movable knife means forward and backward relative to the position of the fixed knife means.

15. The apparatus of claim 14 further including an indicator means connected to said registry changing means to that upon energization of said registry changing means, said indicator means indicates the change in length necessary to produce slots of substantially equal length made by said fixed and movable knife means in said box blank.

16. The apparatus of claim 14 further including an indicator means connected to said phase changing means so that upon energization of said phase changing means, said indicator means indicates the change in arc length between said fixed and movable knife means necessary to produce correct slot orientation in said box blank when a box blank of different size is to be slotted.

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